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The Region of the Axilla

Fractures involving the *anatomical neck* of the humerus are extremely rare, and can only be *suspected*, unless an opportunity is given to explore the joint. The prolongation of the internal and lower fibres of the capsular ligament would connect the fragments unless they were also ruptured. The *superior epiphyseal line* is below the tuberosities, just where the shaft is widest. It does not become obliterated before the twenty-second year. The upper epiphysis may become detached prior to this period, and simulates the condition of a fracture in the upper part of the surgical neck of the humerus without overlapping.

In *amputation at the shoulder-joint* it is essential that the incisions should be made so as to leave the division of the axillary vessels to the last moment. Whatever method is employed, the long tendon of the biceps muscle should be sought for, and by using its bony furrow as a *grooved director* the capsule can be slit up and the joint expeditiously opened. In the *oval flap method*, which the author has found to possess many advantages, the relations of the severed vessels and nerves as they present themselves in the flaps after amputation at the left shoulder are as follows (Plate 50, Fig. 2). The *anterior flap* is formed by the pectoralis major (No. 3), the heads of the biceps, coraco-brachialis, latissimus dorsi, teres major, and rotator muscles. The axillary vessels (Nos. 1 and 2), the cords of the brachial plexus of nerves (No. 11), and the inferior scapular artery and veins (No. 12) will be found in the axillary border of this flap; while the long tendon of the biceps (No. 5), a branch of the anterior circumflex artery (No. 7), and the cephalic vein and the descending branch of the acromio-thoracic artery (No. 8) occupy the acromial border of the flap in relation to the severed clavicular portion of the deltoid muscle. The *posterior flap* is formed mainly by the scapular portions of the deltoid muscle (No. 15), with branches of the posterior circumflex vessels and nerves (No. 14).

THE REGION OF THE AXILLA.

The region of the axilla, or armpit (Plates 44 and 45), varies in depth with the position of the arm. It is a pyramidal space, bounded internally by the side of the thorax, externally by the arm, and in front

and behind by prominent muscular folds. The *anterior fold* is formed by the lower border of the pectoralis major muscle (page 253), while the *posterior fold* is formed by the lower borders of the latissimus dorsi and teres major muscles (page 329). The *skin* of the axilla is closely connected with the subjacent superficial fascia, is provided with long hairs which radiate toward the borders of the cavity, and contains numerous sebaceous glands of a reddish-brown color, which are liable to become inflamed and produce superficial abscesses. It also has very large sweat-glands, and a dense net-work of lymphatic vessels in the corium. There is more or less fat in the meshes of the subcutaneous tissue. The deep fascia is called the *axillary fascia.* It is very dense, and bears important relations to the fasciæ of the regions of the neck, thorax, and shoulder. It consists of a close fibrous layer stretching across the base of the axilla, between the anterior and posterior folds. It is continuous with the deep fascia surrounding the pectoralis major muscle (page 255), and with the *costo-coracoid membrane* above, which, since it draws up the axillary fascia toward the clavicle, is known sometimes as the *suspensory ligament of the axilla.* It produces the characteristic "hollow" of this region. The space beneath the axillary fascia is mainly occupied by a quantity of very loose connective tissue and fat, in which pus or extravasated blood often collects to an extraordinary amount, being checked in its progress toward the surface by the fascia. In consequence of the barrier which this fascia also presents laterally, there is a tendency for unrelieved abscess in this region to extend into the neck along the sheath of the vessels in the direction of least resistance. In opening an axillary abscess, a small incision should first be made through the deep fascia of the floor of the space, upon the *inner* side, midway between the two axillary folds. As soon as the pus is reached, the opening can safely be enlarged upon a grooved director. Trifling as this operation may seem to the uninitiated, it is fraught with danger unless due precaution is taken to avoid the important structures on the outer and upper part of the space. The muscles forming the posterior wall of the axilla are the latissimus dorsi, teres major, and sub-scapularis. The anterior wall is formed by the under surfaces of the pectoralis major and minor muscles. Upon the inner wall

are the four upper ribs, with their intercostal muscles, covered by the serratus magnus. The biceps and coraco-brachialis are upon the outer wall, between the convergence of the two axillary folds. At the apex of the space the axillary vessels and nerves descend outwardly from the root of the neck, whence they bring with them a funnel-shaped prolongation of the deep cervical fascia. This communication between the neck and the axilla constitutes the *cervico-axillary passage.* It is bounded by the first rib, the clavicle, and the upper border of the scapula. In order to see the contents of the axilla, the axillary fascia must be removed. Within the layers of this fascia a small artery will sometimes be found, probably arising from the brachial artery, crossing the floor of the space quite superficially. It is noteworthy, as it is directly in the way of the usual incision for opening an axillary abscess. Whenever the knife is used in this region, great caution must be exercised, and after the preliminary incision it is better to resort to the handle of the knife or to the finger to separate the loose connective tissue and thus expose the lymphatic glands, vessels, and nerves, the relations of which deserve particular attention. Not far from the surface the *posterior lateral cutaneous branches of the intercostal nerves* will be found perforating the chest wall between the digitations of the serratus magnus muscle (Plate 45). Of these the posterior lateral branch of the second intercostal nerve is specialized as the *intercosto-humeral nerve,* because it supplies the skin of the inside of the arm as low as the internal condyle (Plate 27, No. 41). It passes across the upper part of the axilla, issuing from the second intercostal space. There is also an intercosto-humeral nerve from the third nerve, which receives a branch from the second and accompanies it in its distribution. The anterior branches of the above two nerves supply the skin upon the side of the chest and on the axillary folds.

The axillary artery is the continuation of the subclavian, and commences at the lower border of the first rib, whence it passes downward and outward along the coraco-brachialis muscle to the lower border of the posterior fold of the axilla. It is separated from the inner side of the shoulder-joint by the insertion of the sub-scapularis muscle into the lesser tuberosity of the humerus. The pectoralis minor muscle (page 255)

PLATE 46.

Figure 1.

The anterior view of the right elbow and forearm of an adult male, with the superficial fascia carefully removed to show the relations of the superficial veins and nerves.

1. The median nerve in the lower third of the arm, overlapping the brachial artery.
2. The brachial artery.
3. The biceps muscle.
4. The external brachial vein.
5. The external (in this case independent) cephalic vein.
6. The median cephalic vein.
7. The musculo-spiral nerve.
8. The fascia from the biceps tendon, passing beneath the superficial veins at the head of the elbow.
9. A branch of the musculo-cutaneous nerve.
10. A branch of the recurrent radial artery.
11. The median veins (in this case double).
12. The radial vein.
13. The radial nerve.
14. The radial artery with its venæ comites.
15. The tendon of the supinator longus muscle.
16. The median nerve, above the wrist.
17. The ulnar nerve.
18. The triceps muscle.
19. The greater internal cutaneous nerve.
20. The lesser internal cutaneous nerve.
21. The internal brachial vein.
22. The anastomotica magna artery.
23. The basilic vein.
24. Branches of the ulnar nerve.
25. Branches of the internal cutaneous nerve.
26. The anastomosing vein.
27. Deep fascia over the flexor muscles.
28. The ulnar vein.
29. The flexor carpi radialis muscle.
30. Branches of the musculo-spiral nerve.
31. Carpal branch of the internal cutaneous nerve.
32. The ulnar nerve.
33. The tendon of the flexor carpi ulnaris muscle.
34. The flexor sublimis digitorum muscle.
35. The ulnar artery and its venæ comites.
36. The external carpal branch of the ulnar artery.
37. The annular ligament.

Figure 2.

Deeper dissection of same arm as Figure 1. The bicipital fascia and the superficial flexor muscles are removed, while most of the superficial veins are retained to preserve their relations.

1. The brachial artery.
2. The biceps muscle.
3. The median nerve.
4. The external brachial vein.
5. The external cephalic vein.
6. The median cephalic vein.
7. The tendon of the biceps muscle.
8. The brachial artery, surrounded by the brachial veins.
9. The musculo-spiral nerve.
10. The communication between the superficial and deep veins, by the vena anastomotica.
11. The anterior interosseous branch of the median nerve.
12. The supinator longus muscle.
13. The median vein.
14. The anterior interosseous artery, with its venæ comites.
15. The radial artery, with its venæ comites.
16. The shaft of the radius.
17. The radial nerve.
18. Carpal branch from the radial artery.
19. The triceps muscle.
20. The internal cutaneous nerve.
21. The ulnar nerve.
22. The basilic vein.
23. The internal brachial vein.
24. Branches of the ulnar nerve, over the internal condyle.
25. The cut attachment of the superficial flexor muscles.
26. The deeper portion of the pronator radii teres muscle.
27. The bifurcation of the brachial artery.
28. The origin of the interosseous artery.
29. A muscular branch from the ulnar artery.
30. The ulnar nerve.
31. The flexor carpi ulnaris muscle.
32. The median nerve.
33. The ulnar artery, with its venæ comites.
34. The pronator quadratus muscle.
35. Carpal branch of the ulnar artery.

Fig 1

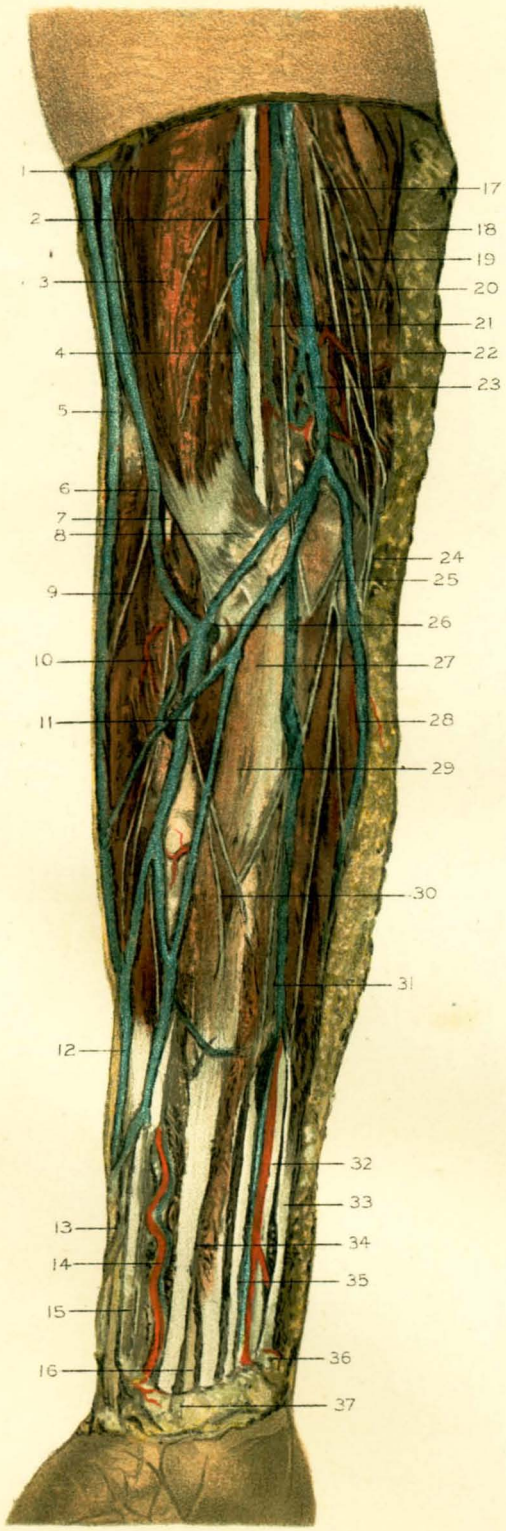
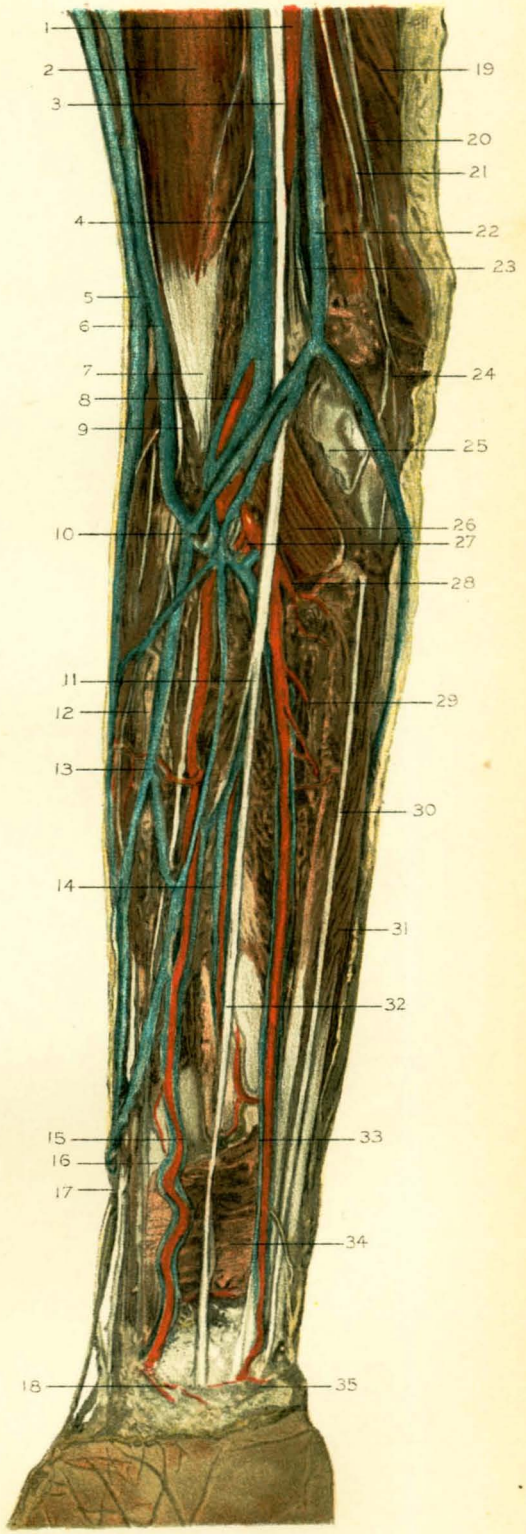


Fig 2



Dissected, Photographed and Colored from Nature by George McClellan M.D.

Armstrong & Co. Lith. Boston.

passes across the middle of the artery to be inserted into the coracoid process, so that the vessel is usually described according to its position,—above, under, or below that muscle. In its course there are many branches from it distributed to the neighboring regions. Above the pectoralis minor the superior thoracic and acromio-thoracic arteries arise independently or by a common axis. The *superior thoracic* passes along the border of the pectoralis minor, and, descending between it and the pectoralis major, supplies them both and anastomoses with branches from the intercostal and internal mammary arteries. The *acromio-thoracic* artery usually divides very near its origin, as it pierces the costo-coracoid membrane, into several branches. They are the small *thoracic* or pectoral, to the serratus magnus and pectoralis minor muscles, the *descending* or *thoracica humeraria* (Holden), which descends in close relation to the cephalic vein between the deltoid and pectoralis major muscles, both of which it supplies, and the *acromial* and *clavicular* branches. The *acromial* crosses the coracoid process to the under surface of the deltoid muscle, and establishes a communication (the *rete acromiale*) with the posterior circumflex and supra-scapular arteries. The *clavicular* supplies the subclavius muscle. The companion veins of these arteries terminate either in the cephalic or in the axillary vein,—generally in the latter.

The *alar thoracic* artery arises variably from the axillary trunk or from its long thoracic branch. It supplies the anterior lymphatic glands embedded in the connective tissue of the axillary space. The *long thoracic artery* (Plate 44, Fig. 1, No. 7) descends close to the lower border of the pectoralis minor muscle. It sometimes gives off the alar artery, but its *external mammary branch* is usually quite large in the female and passes to the breast along the lower border of the pectoralis major. The *short* and *long sub-scapular arteries* are variable in their origin. The *short sub-scapular* is distributed mainly to the under surface of the sub-scapular muscle. The *long sub-scapular artery* is the largest of all the branches of the axillary. It descends in relation to the sub-scapularis muscle and divides into anterior and posterior branches. The anterior or thoracic branch descends in relation to the posterior fold of the axilla to the side of the chest, where it ends in the serratus magnus. It also sends a small

twig to the inferior angle of the scapula which anastomoses with branches from the dorsalis scapulæ and posterior scapular arteries. The posterior branch of the long sub-scapular artery is called the *dorsalis scapulæ* (Plate 45, Fig. 2, No. 17). It passes into the *sub-scapular triangle*, which is formed by the long head of the triceps muscle passing between the sub-scapularis and teres major muscles to its insertion at the inferior border of the glenoid cavity (page 354). Here it gives off a deep branch which breaks up into smaller branches in relation to the ridges of the sub-scapular fossa. The *superior* of these branches is important, because it supplies an articular artery to the shoulder-joint and the principal nutrient artery to the venter of the scapula. The main trunk of the dorsalis scapulæ artery winds round and grooves the axillary border of the scapula under the centre of the attachment of the teres minor muscle. Here it supplies this muscle and the adjoining infra-spinatus muscle, and anastomoses with branches from the *posterior circumflex* and *posterior scapular* arteries. The *veins* which accompany these arteries terminate in the sub-scapular veins, which empty into the axillary veins.

Owing to the many sources of arterial supply to the scapula and its muscles and their free anastomoses, the removal of the scapula, or even of growths involving a portion of it, is attended with profuse hemorrhage. All the main vessels above described require a ligature in these operations, and consequently their *relative* positions should be carefully studied.

The *posterior circumflex artery* is nearly as large in diameter as the sub-scapular. It arises opposite to it, and sometimes with it by a common trunk, and passes backward, accompanied by its two veins and the posterior circumflex nerve, round the posterior surface of the neck of the humerus, to the under surface of the deltoid muscle. This artery establishes communications with the branches from the acromio-thoracic and supra-scapular and the ascending branch from the superior profunda, and supplies not only the neighboring muscles, but also the head of the humerus and the shoulder-joint. The *anterior circumflex artery* is much smaller than the posterior, and passes under the coraco-brachialis and the coracoid head of the biceps close to the anterior surface of the neck of the bone. In relation

to the bicipital groove this vessel gives off the little *bicipital artery*, which accompanies the long head of the biceps to the capsule of the shoulder-joint and to the head of the humerus. It enters the capsule by a foramen at the top of the bicipital groove. The anterior circumflex communicates with the posterior circumflex beneath the deltoid muscle.

There is great variability in the position of the branches of the axillary artery, and sometimes, although rarely, it furnishes the radial or the ulnar artery to the forearm.

When the arm is extended in the supine position, a line drawn from the middle of the clavicle to the point where the anterior axillary fold crosses the inner border of the biceps muscle corresponds to the course of the axillary artery. This line also indicates the position of the *intermuscular cleft* between the sternal and clavicular portions of the pectoralis major muscle, in which the axillary artery can be most easily reached, as it lies upon the first intercostal space below the clavicle. The point where the pectoralis minor muscle crosses the artery may be designated by a line drawn from the coracoid process to the junction of the third rib and its cartilage. The artery is inaccessible for a ligature beneath the pectoralis minor muscle, so that its relations above and below that muscle are of peculiar interest to the surgeon. When tied in the upper part, the collateral circulation is established through the same vessels as after the ligature of the outer part of the subclavian artery (page 232). In the operation for tying the lower part of the axillary artery the incision should be made upon the inside of the bulge of the biceps muscle when the arm is extended, and by following upward along the border of the coraco-brachialis muscle the artery will be found enveloped in its sheath and closely surrounded by the two brachial veins, the basilic vein, and the median and ulnar nerves. In this relation there are often connecting links between the veins extending across the artery, and often, too, accessory slips from the latissimus dorsi muscle to the insertion of the pectoralis major, and therefore, in spite of the artery being more superficial in this locality, it is very difficult of access. The collateral circulation here is similar to that which occurs upon the ligation of the brachial artery above the origin of the superior profunda,—*i.e.*, by the communication of that vessel with

the branches of the posterior circumflex and the neighboring muscular arteries. If, before applying the ligature, the forearm is flexed and the position of the arm is changed, there can be little difficulty in distinguishing between the artery and the nerve-cord of the brachial plexus, which is close to it. This nerve-cord has been mistaken for the artery in several recorded instances.

The axillary vein is the continuation of the basilic vein upward from the lower border of the posterior axillary fold to the outer border of the first rib. In its course it receives as tributaries the venæ comites of the branches of the axillary artery, except the circumflex veins, which either join the sub-scapular or empty into one of the brachial veins. Either just before or at its termination in the subclavian vein the axillary vein receives the two brachial veins and the cephalic vein (Plate 45, Fig. 2). The orifices of the tributary veins are guarded by single valves, but there are double valves at the termination of the main trunk. The axillary vein is more superficial than the artery, and throughout most of its course, when the arm is at the side, the vein is in front of and internal to the artery, but when the arm is slightly raised the vein, although still in front, is below the artery. If the arm is raised to more than a right angle, the vein will *overlap* the artery above the pectoralis minor. Just above its commencement the axillary vein is separated from the artery by some of the nerves of the brachial plexus. The costo-coracoid membrane is intimately adherent to the external coat of the axillary vein where it pierces that dense fascia to empty its blood into the subclavian vein. This attachment serves to keep the vessel open when it is wounded, and probably explains the great rush of blood when it is severed. Its position also renders it liable to be influenced by the inspiratory movements of the chest, and thus air may be drawn into the heart through the vessel if the latter be wounded. In amputation at the shoulder-joint (Plate 50, Fig. 2) it is important to secure the axillary vein with a ligature immediately after tying the axillary artery.

The brachial or axillary plexus of nerves is formed by the anterior branches of the fifth, sixth, seventh, and eighth cervical and first dorsal nerves, each branch consisting of muscular and cutaneous fila-

ments in close association. The fifth receives a descending or communicating branch from the fourth cervical above it, and then joins with the sixth to form the *upper trunk* of the plexus. The seventh cervical pursues an independent course as far as the clavicle, and is the *middle trunk*, while the eighth cervical and first dorsal as they issue from beneath the scalenus anticus muscle unite in relation to the first rib to form the *lower trunk* (Plate 4, Fig. 2, and Plates 20, 25, and 33). The arrangement of the nerves contributing to the plexus is variable, especially upon the left side, but the following corresponds to most of the author's dissections. At the outer border of the scalenus medius muscle the three great nerve-trunks divide into anterior and posterior branches. The anterior divisions from the upper and middle trunks form the *outer cord of the plexus*, the anterior division from the lower trunk furnishes the *inner cord*, and the posterior divisions of the upper and middle trunks unite behind the axillary artery to form the *posterior cord*, which also receives the small posterior division of the lower trunk, but the latter is often found passing directly to form part of the musculo-spiral nerve. At its commencement the plexus is broad (Plate 25), but it becomes narrow opposite the clavicle (Plate 36), and forms below it an intricate interlacement about the axillary artery (Plate 45, Fig. 2) beneath the pectoralis minor muscle. In the root of the neck the nerve-trunks receive some filaments from the cervical ganglia of the sympathetic nerve, and the fifth cervical nerve sends a branch to join the phrenic nerve as it passes down over the scalenus anticus muscle (page 221). The *branches* from the brachial plexus *above the clavicle*, besides the one to the phrenic nerve, are *small muscular nerves* to the longus colli and scalene muscles, and a branch which pierces the scalenus medius and accompanies the posterior scapular artery to supply the levator anguli scapulæ and rhomboid muscles. The *supra-scapular nerve* arises from the upper trunk of the plexus, and passes to the superior border of the scapula *beneath* the supra-scapular artery through the notch in the scapula. It furnishes nerves to the spinati muscles and to the shoulder-joint. The *posterior thoracic nerve* (or external respiratory nerve of Bell) arises usually from the upper trunk, at the outer border of the scalenus medius, and sometimes receives a branch

from the middle trunk. It passes behind the axillary artery, and supplies the serratus magnus muscle, which it enters upon the outer surface (Plate 45, Fig. 2, No. 38).

The *branches below the clavicle* are mainly for the supply of the arm. The *external* and *internal anterior thoracic nerves* arise by filaments from the anterior divisions of the three trunks of the plexus. The *external anterior thoracic nerve* pierces the costo-coracoid membrane in close relation with the acromio-thoracic artery, and supplies the adjacent parts of the pectoralis major muscle. The *internal anterior thoracic nerve* is joined by a filament from the former, and, after passing between the axillary vessels, supplies the pectoral muscles. The *sub-scapular nerves*, three in number, arise from the posterior cord of the plexus and are distributed to the subscapularis, teres major, and latissimus dorsi muscles. The nerve to the last muscle is called the *long sub-scapular nerve*, and accompanies the subscapular artery to the lower border of the muscle. The *circumflex nerve* arises from the posterior cord anterior to the sub-scapular nerves. It is a large nerve, and after sending a filament to the shoulder-joint it accompanies the posterior circumflex artery round the surgical neck of the humerus beneath the deltoid muscle. It divides into many branches, which supply the skin over the deltoid and the upper and back part of the arm (Plate 27, No. 37). Very curiously, the branch of the circumflex nerve which supplies the teres minor muscle possesses a small pseudo-ganglion close to its origin. Branches also pass to the front and back parts of the capsular ligament. The terminal branches of the brachial plexus are described with the arm (page 357).

The lymphatic glands of the axilla (Plates 44 and 45) receive the lymphatic vessels from the upper extremity, from the back, from the anterior portion of the chest, and from the *outer* portion of the mammary gland (page 251). They form a continuous chain with the cervical lymphatic glands passing beneath the clavicle to the root of the neck. They are about a dozen in number, of variable size, and are mostly in close relation to the axillary vein and its larger tributaries. There is also a cluster of the glands situated more superficially than the deeper ones, and embedded in the loose connective tissue and fat of the axillary space. The

thoracic and sub-scapular arteries furnish blood to the deeper glands, while the superficial ones are supplied by the alar thoracic artery. The lymphatic vessels from the outer side of the arm and shoulder pass to a couple of glands in the groove between the deltoid and pectoralis major muscles, over the costo-coracoid membrane, near the cephalic vein. The efferent vessels from these usually pass to the cervical glands directly, while the lymphatic vessels from the inner side of the arm terminate in three glands situated along the axillary vein. A gland is generally found in relation to the sub-scapular artery, and another on the tendon of the latissimus dorsi close to the humerus. The superficial lymphatic vessels of the back are derived from the whole expanse of that region, from the nape of the neck to the loins. They converge to the axilla, and end in the glands in the upper and back part of the cavity.

The lymphatic vessels from the nipple, the areola, and the outer portion of the breast convey their lymph to two or three glands situated upon the serratus magnus muscle under cover of the lower border of the pectoralis major muscle. The efferent vessels from all the axillary glands resolve themselves into four lymph-trunks, which pass along with the subclavian vein and terminate upon the right side in the right lymphatic duct and upon the left side in the thoracic duct (page 318). When the axillary glands are in a normal condition they cannot be felt through the skin; and it is not always possible to detect them even when they are slightly enlarged. Their secondary involvement in scirrhous disease of the breast is so common that it is advisable in all such cases, when an operation is resorted to, to extend the incision into the axillary space, so that the finger can thoroughly explore the cavity. With the exception of the removal of the chain of cervical glands from about the internal jugular vein, there is no operation of a similar nature more trying to the skill and patience of the surgeon than the removal of the axillary glands about the axillary vessels. They are closely associated at all times with the thin walls of the great veins in this region, but when implicated with disease their relation is of the most intimate character, and they have literally to be peeled off one by one, at imminent risk of rupturing the veins. No rough handling of the structures in the apex of the axilla

during an operation would be countenanced by one whose scalpel had ever unravelled the intricacies of these parts in his student days.

THE REGION OF THE ARM.

The arm extends from the axilla to the elbow. It has already been stated (page 332) that the shape of the shaft of the humerus above the deltoid insertion is cylindrical; below it is prismatic and slopes gradually downward and slightly forward to the lower end, where it becomes transversely flattened (Plate 28). The central portion of the lower end of the humerus is peculiarly formed for articulation with the ulna. It is called the *trochlea*, and consists of a smooth, rounded, condyloid surface, which is constricted at the middle so that the inner portion is somewhat larger and projects lower than the outer. Above the constriction anteriorly there is a depression for the reception of the coronoid process of the ulna when the forearm is flexed, called the *coronoid fossa*. Posteriorly there is a similar but larger depression, the *olecranon fossa*, for the olecranon process of the ulna when the forearm is extended. The portion of bone between these fossæ is exceedingly thin and translucent, and sometimes perforated, forming the *supra-trochlear foramen*. Jutting out from the internal portion of the trochlear surface is a prominent process, the *internal epicondyle*, and to the periosteum over this process the flexor muscles of the wrist and hand are attached. The internal epicondyle looks directly inward when the arm hangs naturally at the side, and occupies a lower plane than the *external epicondyle*, which is the corresponding process upon the outer portion of the trochlear surface. The latter is rough and comparatively short, and gives attachment to the origins of some of the extensor muscles. Upon the outer surface of the trochlea is a small spheroidal forward projection, called the *capitulum*, upon which the cup-shaped depression on the head of the radius rests and glides within the elbow-joint. The outer and inner borders are directly continuous with the epicondyles, and are known as the *external* and *internal supra-condyloid ridges*. Upon the posterior surface of the *internal* epicondyle there is a slight *groove for the ulnar nerve*. The epicondyles are the only parts of the humerus which are subcuta-